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RECEIVING AND COUPLING PART FOR OPTO-ELECTRONIC TRANSMISSION AND/OR RECEPTION ELEMENT

Cross-Reference to Related Application:

This application is a continuation of copending International Application No. PCT/DE02/00903, filed March 8, 2002, which designated the United States and was not published in English.

Background of the Invention:

Field of the Invention:

The invention relates to a receiving and coupling part for an opto-electronic transmission and/or reception element. The receiving and coupling part with a corresponding transmission and/or reception element is preferably part of an inexpensive opto-electronic module that is coupled with a POF (plastic optical fiber).

Published German Patent Application DE 199 09 242 A1 describes an opto-electronic module having a carrier with an opto-electronic converter positioned in a modular housing. The carrier is surrounded by a transparent moldable material that protects the optical and electrical components from environmental influences. A relatively long processing time is required for curing because of a relatively large casting

volume. Another disadvantage is that differences in the coefficients of expansion of the carrier, components, and casting compound result in a limited stability with respect to temperature fluctuations, and stresses arise. The larger the housing and the packaged parts are, the greater the resulting stresses are.

In the known housing, an angle of 90° exists between the casting opening of the housing and the optical axis of a coupling region for accepting an optical fiber. This can cause problems in the production of lenses in the molding body, since an air bubble will form given an incomplete filling of the lens mold, which sharply reduces the effectiveness of the lens.

Summary of the Invention:

It is accordingly an object of the invention to provide a receiving and coupling part for a transmission and/or reception element, which overcomes the above-mentioned disadvantages of the prior art apparatus of this general type.

In particular, it is an object of the invention to provide a receiving and coupling part enabling a transmission and/or reception element to be configured in a transparent casting compound and enabling an optical fiber to be easily coupled. It is another object of the invention to provide a receiving

and coupling part that has a large measure of stability against temperature fluctuations. At the same time, the formation of air bubbles at a lens that is integrated into the casting compound must be prevented to the greatest possible extent.

With the foregoing and other objects in view there is provided, in accordance with the invention, a receiving and coupling unit formed with a cylindrical recess, one end of which contains the transmission and/or reception element, and the other end of which serves for receiving and coupling an optical fiber. The receiving and coupling part thus substantially includes a cylinder having an end at which the molding body is formed. The receiving and coupling part is thus provided with a simple symmetrical and inexpensive structure.

The filling of the receiving and coupling part with the casting material can proceed in the direction of the optical axis of the cylindrical recess, i.e. in the direction of the cylinder axis. The other end of the cylinder is sealed on the bottom with a stamp having a negative lens shape. The positive lens shape forms therein by means of molding. Because the casting body is formed directly in the cylindrical recess at which the optical fiber will be coupled, the casting material can be kept as small as possible, and consequently

stresses based on different coefficients of expansion are reduced. In addition, the curing time is shortened accordingly. Because the casting direction coincides with the optical axis and is not at a 90° angle to the axis as in the prior art, the lens is always completely filled with casting material during the filling process, which eliminates the risk of air bubbles remaining in the lens region.

Alternatively, it can also be provided that a carrier and, during the filling process, the casting compound as well, are inserted by way of an opening in the wall of the cylindrical recess at an angle of 90° to the optical axis. In this variant of the invention, one end of the cylindrical recess is preferably provided with a sealing cap. The wall of the receiving and coupling part preferably consists of a conductive plastic material and/or is sheathed in a conductive electrical layer. The electromagnetic radiation in the optical transmission element is thus absorbed and can exit the open part (i.e. the coupling region) of the receiving and coupling part only in a highly dampened form. The cylindrical recess thus acts something like a hollow conductor that is being driven far above the cut-off wavelength.

The carrier is preferably a leadframe. The receiving and coupling part can preferably be connected to ground lines by way of the leadframe. The lines are inserted into the

receiving and coupling part in such a way that an optical transmission and reception element can be aligned in all three dimensions relative to the optical axis and the exterior dimensions of the receiving and coupling part. Moldings are therefore provided, which set the optical elements and the optical axis in relation to the outer diameter of the receiving and coupling part in a simple joining step. The positioning of the optical element on the leadframe thus occurs with a high position precision relative to the optical axis.

The inner diameter of the cylindrical recess matches the outer diameter of an optical fiber that is to be coupled. By the insertion of the optical fiber – which is a plastic fiber, an HPCS/HCS fiber, or a multimode glass fiber with a core diameter of 50 µm – into the receiving and coupling part, the optical fiber is securely held on the optical axis.

In a preferred development of the invention, the leadframe extends parallel to the optical axis of the cylindrical recess of the receiving and coupling part. To a certain extent, it is thus led away from the back of the receiving and coupling part. The advantage of this is the small dimension of the receiving and coupling part perpendicular to the optical axis. The disadvantage is that, with the leadframe aligned parallel to the optical axis of the cylindrical recess, the optical

transmission and/or reception element must be mounted on a portion of the leadframe that is bent 90°.

In an alternative development, the leadframe is installed vertical to the optical axis of the cylindrical recess. That way, the optical converters can be built on a planar leadframe.

According to a preferred development of this variant, the leadframe, outside the receiving surface for the optical transmission and/or reception element, is bent in the shape of an S prior to a filling of the receiving and coupling part, namely the cylinder, in the direction of the optical axis. This guarantees that the receiving surface for the optical transmission and/or reception element protrudes into the interior of the cylindrical recess.

The receiving and coupling part, which, as described above, either consists of an electrically conductive material or possesses a galvanically applied metal sheathing, is either non-conductive or is insulated from the leadframe at the location where the leadframe is led out of the receiving and coupling part vertically to the longitudinal axis.

For the purpose of positioning the leadframe, passive aligning structures are preferably provided at the receiving and coupling part and the leadframe, which interlock.

In a preferred development, the optical transmission and/or reception elements are installed on a completely planar leadframe, not an S-shaped leadframe. The planar leadframe is led into the cylindrical recess through a side opening in the wall of the receiving and coupling part. It is positioned exactly on the optical axis of the cylindrical recess.

The receiving and coupling part is cylindrical in the region of the fiber guidance, so that the optical fiber is led in the inner cylinder. The receiving and coupling part can be fixed in a plug housing by the outer cylinder. The receiving and coupling part includes passive aligning marks for the assembling of the receiving and coupling part at a plug housing and/or circuit board.

It can be further provided that ridges for mechanical locking are installed on the outer cylinder, i.e. on the exterior of the wall of the cylindrical recess. That way, the receiving and coupling part can be prevented from sliding out during its assembly at a plug housing. Such locking devices, which are U-shaped, for example, can be constructed differently for a receiving and coupling part with a transmission element or

with a reception element. A locking mechanism could also be provided in an annular form on the exterior wall by a small wedge-shaped elevation.

It is not always necessary to use two separate receiving and coupling parts for realizing the transmission and reception components of a transceiver. It can also be provided that the receiving and coupling part is constructed as a double chamber including the transmission and reception elements in separate parallel regions. The spacing of the two cylinder axes corresponds to the spacing of the two axes of the optical fiber of a mechanical plug system. Locking with a clock type rotation is then no longer possible. Locking occurs by using a wedge shaped ring structure on the two outer cylinders, for example.

A passive alignment is provided in this exemplary embodiment by the dimensions of the two outer cylinders, which fit positively into the corresponding recesses at an appertaining plug housing. In order to suppress an electrical crosstalk from the transmission converter onto the reception converter, the connecting wall between the two chambers is electrically conductive. This can be realized by using an electrically conductive casting compound, for example.

Another embodiment provides openings in the connecting wall for preventing electrical crosstalk. These openings are constructed such that they are coated or filled with an electrically conductive layer, and they represent a metallically conductive wall for the electromagnetic radiation.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in a receiving and coupling part for opto-electronic transmission and/or reception element, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

Fig. 1 is a sectional view showing the basic structure of a receiving and coupling part;

Fig. 2 is a sectional side view and a plan view of the receiving and coupling part constructed as shown in Fig. 1, but with ground pins thereon;

Fig. 3 is a sectional view taken through another exemplary embodiment of a receiving and coupling part together with a plug housing that can be placed on the receiving and coupling part;

Fig. 4 is a sectional view taken through a receiving and coupling part during the arranging of a photodetector;

Fig. 5 is a sectional view taken through a receiving and coupling part while configuring a transmission element and subsequent to separating the leadframe;

Fig. 6 are front and sectional views of a fully assembled receiving embodiment of a receiving and coupling part;

Fig. 7 are front and sectional views of a fully assembled transmission embodiment of a receiving and coupling part;

Fig. 8 is a schematic view showing the coupling of a receiving and coupling part in a plug housing;

Fig. 9 are side, rear, and front views of another exemplary embodiment of a receiving and coupling part;

Fig. 10 shows a step of attaching a receiving element on a leadframe in a method for producing the receiving and coupling part shown in Fig. 9;

Fig. 11 shows a step in fabricating the receiving and coupling part shown in Fig. 9;

Fig. 12 shows an exemplary embodiment of a receiving and coupling part with a receiving element that has been slightly modified compared to the exemplary embodiment represented in Fig. 9;

Fig. 13 is a front view of a receiving and coupling part having a carrier with both a transmission diode and a monitor diode;

Fig. 14 shows an alternative development of a receiving and coupling part with a planar carrier;

Fig. 15 are side and sectional views of the receiving/coupling part represented in Fig. 14 during the fabrication thereof; and

Fig. 16 shows a step in the fabrication of several receiving and coupling parts.

Description of the Preferred Embodiments:

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is shown the basic components of a receiving and coupling part. These components consist of a cylinder 1, which includes a wall 101 that defines a cylindrical recess 102 and surrounds the recess 102. The cylinder 1 is symmetrically constructed and includes an optical axis 103. The axis 103 forms the optical axis of a transmission or reception element that is disposed in the receiving and coupling part in a casting material. The cylinder 1 consists of a conductive injection molding material or is surrounded by an electrically conductive sheathe.

For receiving a leadframe that forms a carrier and that includes the respective optical converter element (for instance a photodiode or RCLED), the receiving and coupling part is provided with receiving sockets 104, and the cylinder wall is reinforced in this region 105. Ground pins of the leadframe are inserted into the receiving sockets 104. These

ground pins guarantee the ground connection of the receiving and coupling part with the printed circuit board for ground shielding purposes.

The receiving and coupling part is also referred to as a CAI (cavity-AS interface) housing that serves for receiving a transmission and/or reception element disposed on a carrier in a casting material and also for coupling an optical fiber. The receiving and coupling part is referred to as the CAI housing hereinafter.

Fig. 2 shows slight variants in which the ground pins 104' are co-injected directly when fabricating the CAI housing. The aligning of a leadframe then occurs by way of guide slots 106 at the margin region of the cylinder 1.

All geometric dimensions are defined by the CAI housing with reference to optically coupling an optical fiber. Thus, the dimensions of the outer diameter, inner diameter, and open path distance to the casting body in the CAI housing represent a standardized mechanical interface to a plug that is to be attached. The dimension of a plug housing must match the dimensions of the CAI housing so that the CAI housing can be fit into a plug housing.

Fig. 3 shows the essential dimensions A, B, C, D that must be transferred from the CAI housing into a plug housing 2.

In the exemplary embodiment shown in Fig. 3, the cylinder 1 also has a reinforced region 105. A positive region, for instance a surrounding trench 107 is provided, which allows the locking of the cylinder 1 of the CAI housing in the wall of the plug housing 2. Completely surrounding the CAI housing by the plug housing 2 is therefore unnecessary. Rather, the cylinder 1 of the CAI housing can protrude into the plug housing 2 freely like a beak.

Fig. 4 shows a section through a structure for fabricating a photodetector. The CAI housing with the cylinder 1 is sealed on the bottom by a stamp 3. A coupling lens 302 is constructed on the stamp surface 301 in negative form and with a fiber stop locking mechanism. The fiber stop locking mechanism, a fiber stop ring to be exact, is constructed in the outer region and includes a nose 303 with a length of 50 μm relative to the lens vertex. A leadframe 4 with a photodiode 5 has been immersed in the casting body and is cured. The cylinder interior is filled with a casting compound in the direction of the optical axis, i.e. from above.

The leadframe forms a cathode contact K and an anode contact A, which extend in the direction of the optical axis. The photodiode 5 is contacted using bond wires 6a, 6b, respectively.

Fig. 5 shows a configuration corresponding to the configuration of Fig. 4, but with a transmission element 6. It is noted that the leadframe with the contact elements K, A forms a 90° angled region 401 on which the transmission element 6, or the reception element 5 in Fig. 4, is mounted.

Fig. 6 shows front and sectional views of the CAI housing constructed in a receiver embodiment and mounted on an Al-laminated flex film circuit carrier. The "optics" are limited to the region of the transparent casting body. The electrical wiring is realized as known in the prior art. The Al film serves for shielding against electromagnetic radiation as well as for heat removal.

Fig. 7 shows a CAI housing constructed in a transmission embodiment and mounted on an Al-laminated flex film circuit carrier.

Fig. 8 shows the CAI housing constructed in a receiver embodiment with an SMI (small multimedia interface) plug housing 2. An attached POF (plastic optical fiber) plug 7

with an optical fiber 8 is inserted into the CAI housing and fixed in place exclusively by the dimension of the CAI housing. A mechanical interface exists. With this design, any form of plug can be provided with an optical transceiver consisting of a transmitting and receiving module, while at the same time the standardized mechanical dimension of the CAI housing is preserved.

Fig. 9 shows an exemplary embodiment wherein the leadframe 4 is led from the cylinder 1 vertically relative to the optical axis. The leadframe is therein bent into an S shape, so that it protrudes in the interior of the cylindrical recess 102 and is completely covered during the filling with a casting material.

Fig. 10 shows the leadframe 4 with a receiver diode 5. It can be recognized in the sectional view that the leadframe is curved in the shape of an S.

Fig. 11 shows the receiving and coupling part after placing the leadframe into the CAI housing. The CAI housing formed by the cylinder 1 has two open ends. The lower end is sealed by a stamp 3. The casting material is filled in using the upper end. After curing the casting material, the stamp is removed.

Fig. 12 shows a slight alternative development of the CAI housing of Fig. 11 wherein additional passive aligning elements 18 are provided.

Fig. 13 shows an exemplary embodiment in which a monitor diode 9 is attached to the leadframe in addition to a transmission diode 6.

In the exemplary embodiment shown in Fig. 14, the leadframe is disposed perpendicular to the optical axis. But the leadframe is constructed planar. Accordingly, it is inserted into the cylindrical recess 102 by way of a side opening 10 in the wall of the cylinder 1. A filling with casting material also occurs by way of opening 10.

Fig. 15 shows the receiving and coupling part subsequent to the introduction of a stamp 3 on one end of the cylinder 1. In order to provide a cavity for filling, the other end of the cylinder is sealed with a cap 11.

Lastly, Fig. 16 shows a step in a method in which a common leadframe is used for several CAI housings. Subsequent to bending the leadframe legs using a press element 12, the legs are separated along a cut line 13.

It should be noted that the invention is not limited to the described exemplary embodiments, but encompasses modifications and variations that fall within the scope of protection defined by the claims.